Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
TOTAL	

AQA

General Certificate of Secondary Education
June 2013

Design and Technology: Systems and Control Technology 45651

Unit 1 Written Paper

Wednesday 22 May 2013 1.30 pm to 3.30 pm

For this paper you must have:
- a black pen, a pencil, a ruler, an eraser and a pencil sharpener.

Time allowed
- 2 hours

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this answer book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 120.
- The question in Section A relates to the context referred to in the Preliminary Material that was previously issued.
- You are reminded of the need for good English and clear presentation in your answers. Quality of Written Communication will be assessed in Question 4(d).

You may need to use one or more of the following formulae when answering questions which include calculations.

Potential Difference $V = I \times R$

Series Resistance $R_T = R_1 + R_2$

Potential Divider

$$\text{Voltage 1} = \frac{R1}{R1 + R2} \times \text{Supply Voltage}$$

$$\text{Voltage 2} = \frac{R2}{R1 + R2} \times \text{Supply Voltage}$$

Ratio of Simple Gears

$$\text{Gear ratio} = \frac{\text{Number of teeth on driven gear}}{\text{Number of teeth on driver gear}}$$

Velocity Ratio

$$\text{Velocity ratio} = \frac{\text{Diameter of driven pulley}}{\text{Diameter of driver pulley}}$$

$$\text{Output speed} = \frac{\text{Input speed}}{\text{Gear / Velocity ratio}}$$

Mechanical Advantage $MA = \text{Load} / \text{Effort}$

Section A

Answer all questions in the spaces provided.

You are advised to spend about 35 minutes on this question.

1 This question is about designing an automatic system for bird photography.

Many bird watchers would like to have a photograph of birds visiting their bird feeder.

A manufacturing company have asked you to design an automatic system to operate a camera when a bird is present.

1 (a) The first stage is to produce a Design Specification.

For each of the following specification points, give an example of an issue you will need to consider. You should explain your answer.

An example response has been given to help you.

Functional specification point -

The system must be waterproof to prevent rain damage.

1 Safety specification point

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(2 marks)

2 Power supply specification point

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(2 marks)

3 Aesthetic specification point

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(2 marks)

1 (b) Using notes **and** sketches, design a system in the following boxes that meets each of the relevant criteria.

1 (b) (i) The system can sense that a bird is present.

(3 marks)

1 (b) (ii) The system can sense that it is not completely dark.

(3 marks)

1 (b) (iii) The system can operate the camera.

(3 marks)

1 (b) (iv) The system can let the bird watcher know that the camera has taken a picture.

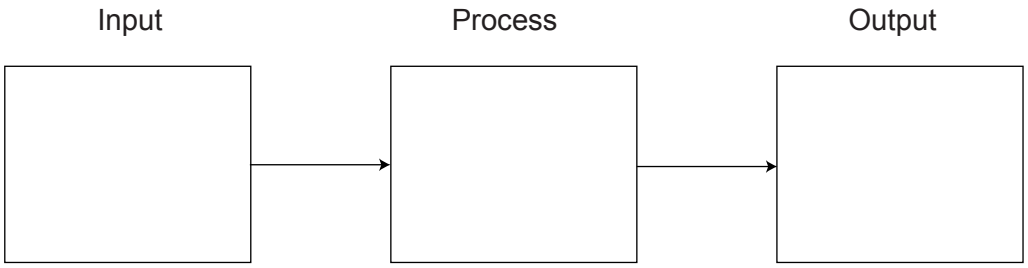
(3 marks)

1 (b) (v) The system is suitable for use outside in the rain.

(3 marks)

1 (c) Give each stage of operation in the automatic system to operate a camera when a bird is present.

Complete the system block diagram below.



(3 marks)

1 (d) State **two** suitable output devices to let the bird watcher know that the camera has taken a picture.

Give a suitable design advantage for each device.

Output device 1 .....

Advantage of output 1 .....

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Output device 2 .....

Advantage of output 2 . .....

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(6 marks)

1 (e) The case for your system will be manufactured in a batch of 20 000.

State a suitable material and process for the manufacture of 20 000 cases for the system you have designed.

Give a reason for your choice.

Material .....

Process .....

Reason .....

.....

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(4 marks)

34

Section B

Answer all questions in the spaces provided.

You are advised to spend about 20 minutes on this question.

2 This question is about mechanical drive systems.

2 (a) Complete the following table.

Give an advantage and disadvantage of each type of drive system with an example of a product that uses the drive system.

Drive system	Advantage	Disadvantage	Example
Gears			
Belt and Pulley			
Drive Shaft			

(9 marks)

2 (b) Friction can be an advantage or a disadvantage.

Describe a system where friction is an advantage.

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Describe a system where friction is a disadvantage.

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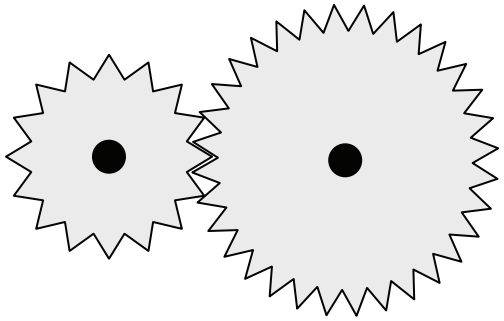
(4 marks)

2 (c) Calculate the gear ratio of the gears below.



Formula.....

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Calculation .....

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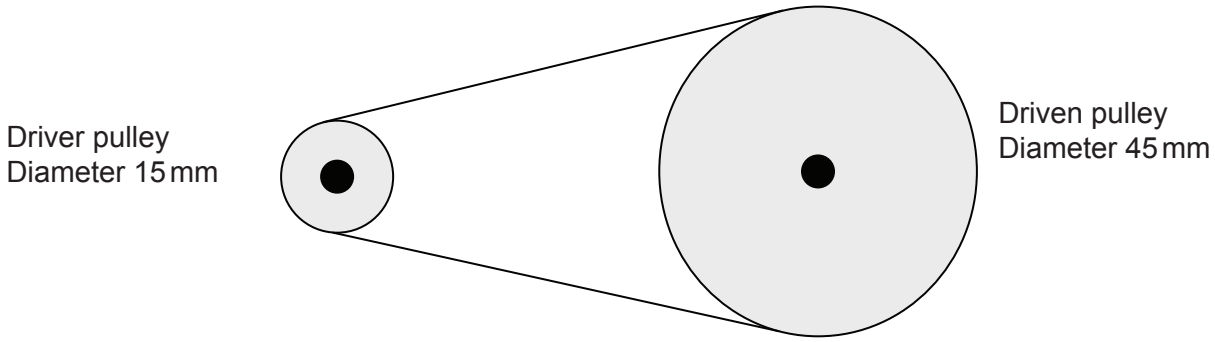
Answer.....

(3 marks)

2 (d) Calculate the velocity ratio of the pulleys below.



Formula .....

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Calculation .....

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Answer .....

(3 marks)

2 (e) Calculate the output speed of the pulley system above if the input speed is 1000 rpm.

Formula .....

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Calculation .....

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Answer .....

(3 marks)

22

You are advised to spend about 15 minutes on this question.

3 This question is about Printed Circuit Boards (PCBs).

3 (a) Suggest **two** reasons for using a PCB in a commercial electronic product.

Reason 1 .....

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Reason 2 .....

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(4 marks)

3 (b) State **two** hazards and **two** relevant safety precautions to be taken when soldering components to a PCB.

Hazard 1 .....

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Safety precaution 1.....

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Hazard 2 .....

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Safety precaution 2.....

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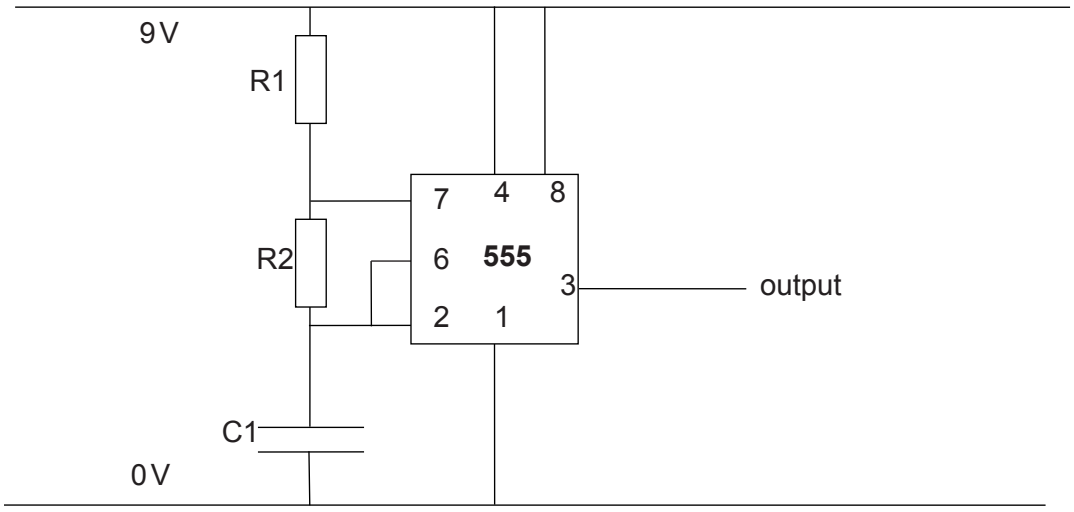
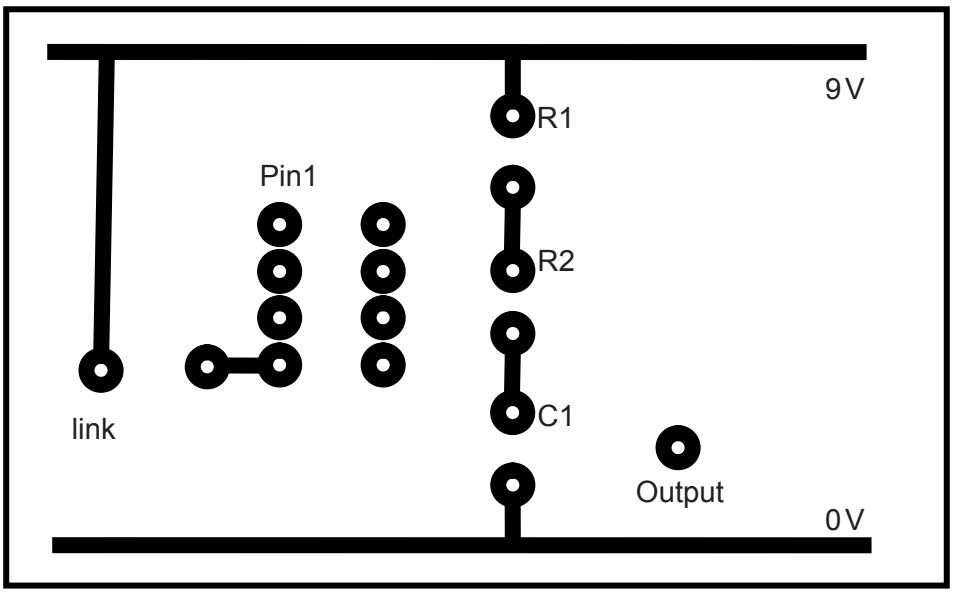
(4 marks)

3 (c) Shown below is a circuit diagram for a commercial electronic product.



Complete the PCB layout diagram below for the circuit shown above.

The PCB layout is viewed from the component side.



(6 marks)

14

You are advised to spend about 20 minutes on this question.

4 This question is about social, cultural, moral and environmental issues.

4 (a) A company is considering purchasing robots to manufacture their products.

Explain an advantage and a disadvantage of using robots in manufacturing.

Advantage .....

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Disadvantage .....

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(4 marks)

4 (b) A UK company is considering moving the manufacturing of its products to China.

Explain the benefits for the company of manufacturing their products in China.

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(4 marks)

4 (c) A multinational company is using a production process that is legal to use in some countries but is considered too dangerous to be used legally in the UK.

Discuss whether or not the company should use this production process in those countries where it is legal to do so. Give reasons for your answer.

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(4 marks)

Question 4 continues on the next page

4 (d) Explain how manufacturers can design sustainability into a product.

Give examples in your answer.

You will be tested for quality of written communication in this part of the question.

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(8 marks)

20

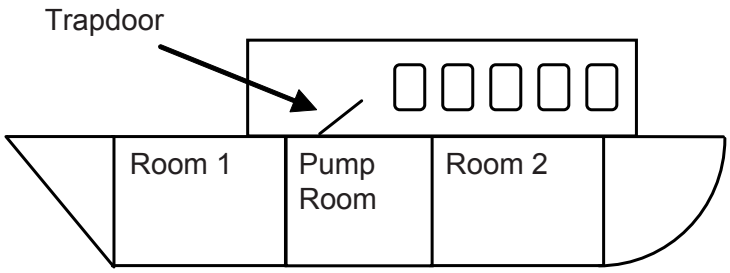
Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

You are advised to spend about 15 minutes on this question.

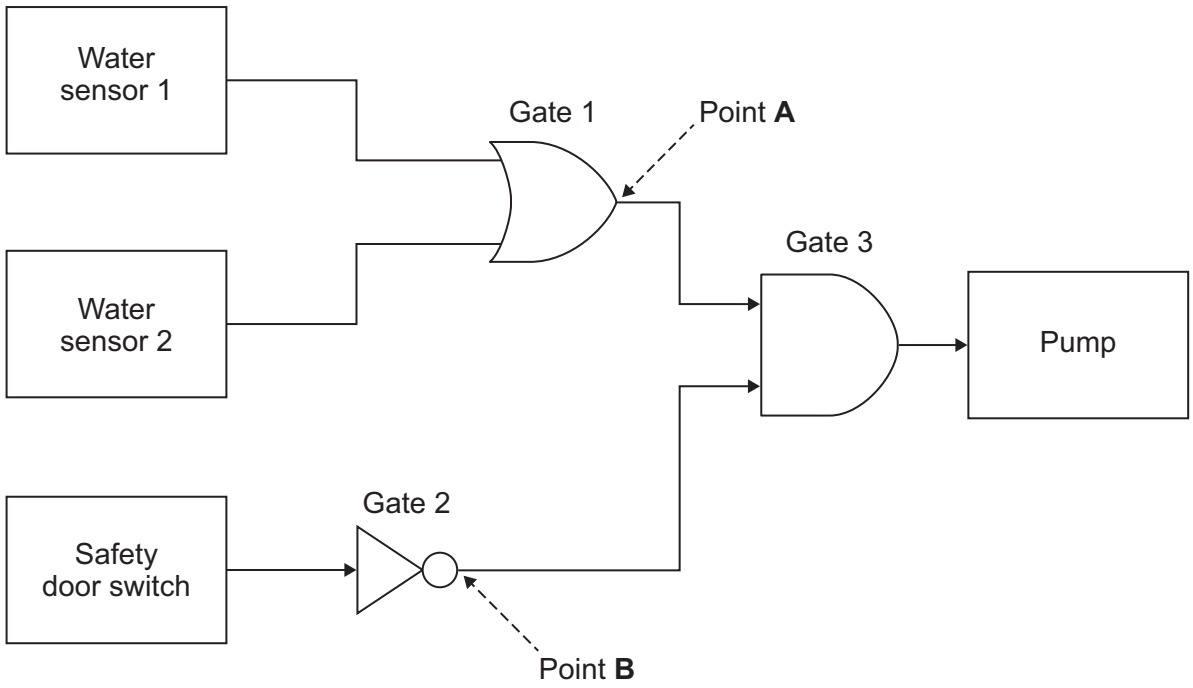
5 This question is about a system that automatically turns on a boat's pump.

The diagram below shows a boat with a pump room and two other rooms.



If water is present in either Room 1 or Room 2, and the trapdoor to the pump room is closed, the pump automatically starts working.

The following diagram shows the logic for the boat pump system.



Water Sensor	Dry	0
Water Sensor	Wet	1
Safety Door Switch	Closed	0
Safety Door Switch	Open	1

5 (a) Name the gates in the logic diagram shown opposite.

	Logic Gate Name
Gate 1	
Gate 2	
Gate 3	

(3 marks)

5 (b) If water is present in **either** Room 1 or Room 2 **and** the trapdoor to the pump room is closed, the pump automatically starts working.

Complete the following truth table for the logic circuit shown opposite.

Inputs			**Process**		**Output**
Water Sensor 1	**Water Sensor 2**	**Safety Door Switch**	**Point A**	**Point B**	**Pump ON**
0	0	0	0	1	0
0	0	1	0	0	0
0	1	0	1	1	1
0	1	1	1	0	0
1	0	0			
1	0	1			
1	1	0			
1	1	1			0

(4 marks)

5 (c) Use notes and sketches to show a suitable sensor for sensing that water is present in a room.

(4 marks)

5 (d) Suggest **two** advantages of using a Microcontroller (PIC) rather than discrete Logic Integrated Circuits (ICs) in an electronic product.

Advantage 1 .....

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Advantage 2 .....

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(4 marks)

15

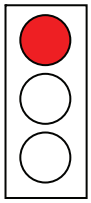
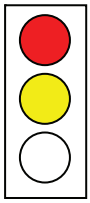
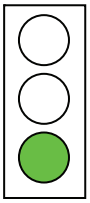
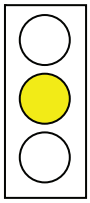
Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

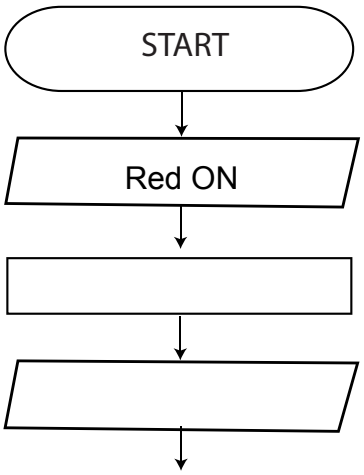
You are advised to spend about 15 minutes on this question.

6 This question is about programming a microcontroller (PIC) to control a traffic light.

6 (a) The lights should repeatedly cycle through the following sequence.

			
30 Seconds	2 Seconds	30 Seconds	2 Seconds

Complete the flowchart below to show how to program the microcontroller (PIC) to control the traffic light.



(12 marks)

6 (b) Fully explain why Light Emitting Diodes (LEDs) are replacing lamps in modern traffic lights.

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(3 marks)

15

END OF QUESTIONS